An Introduction to HarborSym

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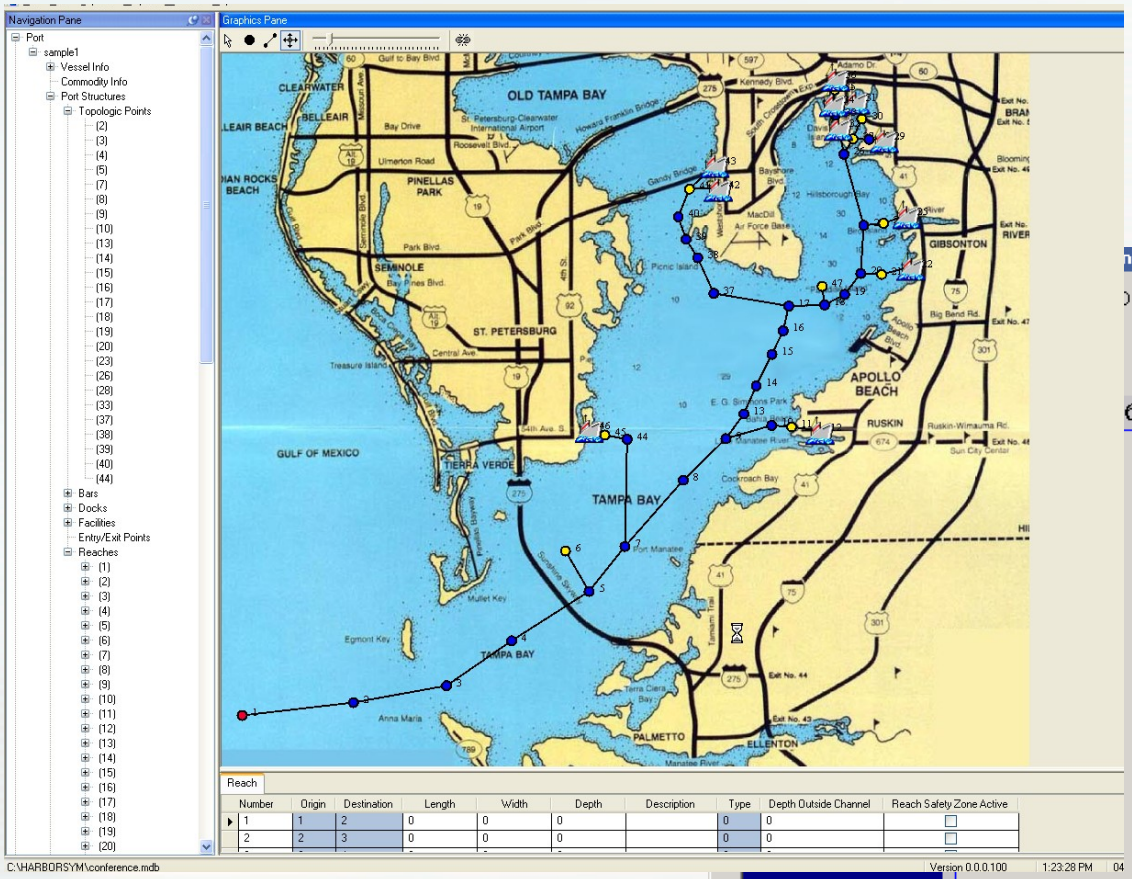
NETS Program

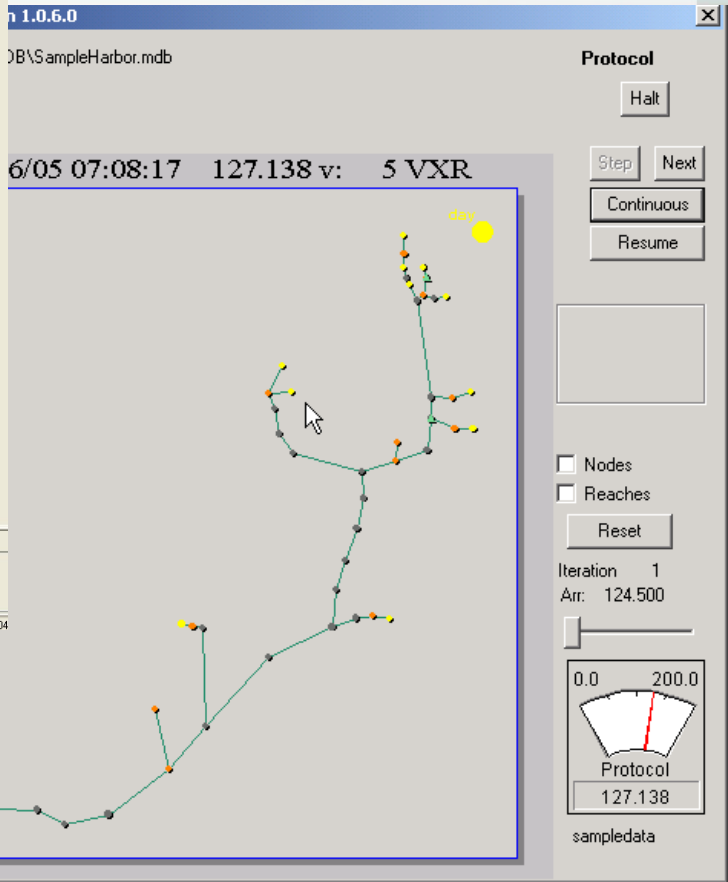
- **The goal of NETS is to advance the Corps world-class engineering with state-of-the art tools and techniques for economic modeling and analysis.**
- **Three levels of Models**
  - **Macro - Global Grain Model**
  - **Meso - Regional Routing Model**
  - **Micro - Project level models**
- **Attempt to develop models to improve planning and project studies for field research**
- **Work continues to FY 08**

Is this the best way to do a study….

ow do we move from data into analysis while providing useful information?

Can you turn a port into a Model?





Outline for Harbor Sym

- **Introduction**
- **Building a network**
- **Vessel Traffic**
- **Forecasting Commodity Flows into Vessels**
- **Outputs**
- **Training**

HarborSym Models

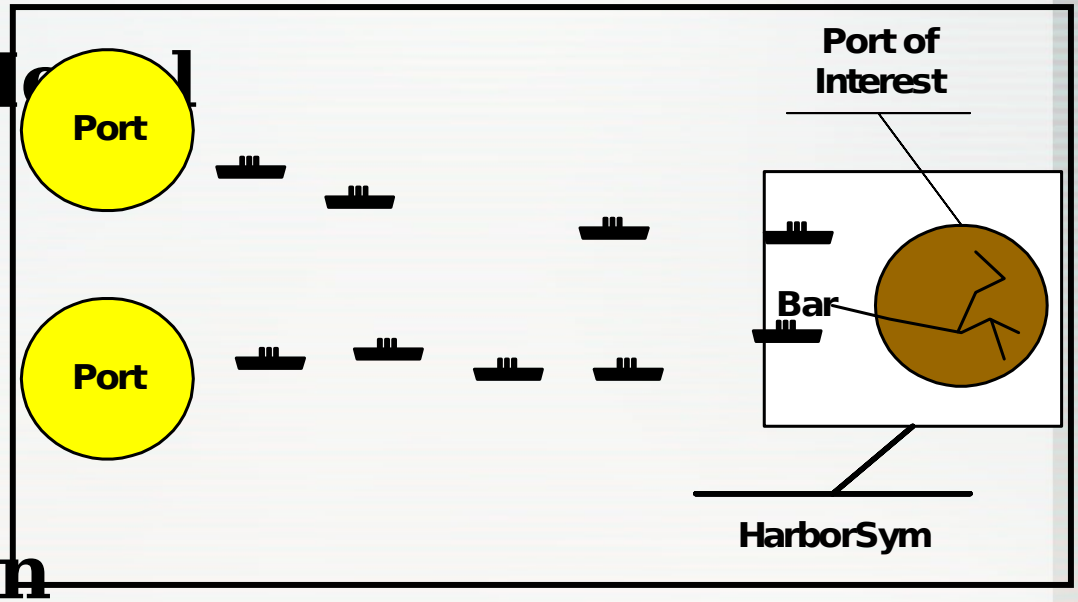
- **HarborSym: NETS Component -Deep Draft**
- **Status: Beta**
  - **HarborSym Widening Model**
  - **HSAM Visualization**
- **Status: Development/Testing**
  - **Vessel Allocator / Forecaster**
  - **Data Development Tools**
- **Status: Design**
  - **HarborSym Deepening Model**

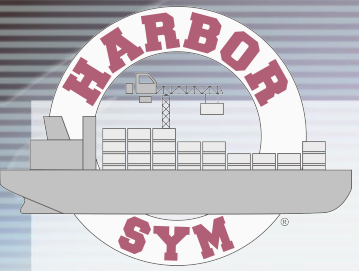
Event-Based Monte Carlo Life Cycle Model

- **Life Cycle**
  - **number of years = iteration = series of events = economic life of project (e.g. 50 years)**
- **Event - behavior / action at a specific time in life cycle**
  - **Fixed Time Step (monthly, weekly, daily)**
  - **Relative - events triggered by previous events**
- **Time moves forward, event to event**
- **At each Event: Simulate behavior, record activity, accumulate statistics**
- **Each life cycle, record summaries**
- **Each run, statistics on life cycle results**

HarborSym Model

- **Planning-Level Model**
- **Data Input**
  - **Port layout**
  - **Vessel Calls**
  - **Speeds**
  - **Transit Rules**
- **Model Calculation**
  - **Vessel interactions within harbor**
- **Assumptions**
- **Output**
  - **Times in system (travel, docking, etc.)**
  - **Delay times**





Complexity trying to overcome

- **Real world system complicated, hard to model / simulate**
- **Port-specific rules**
- **Need to express everything in user-specified data (not in code)**
- **Data intensive**
- **Data sensitive (need quality data)**

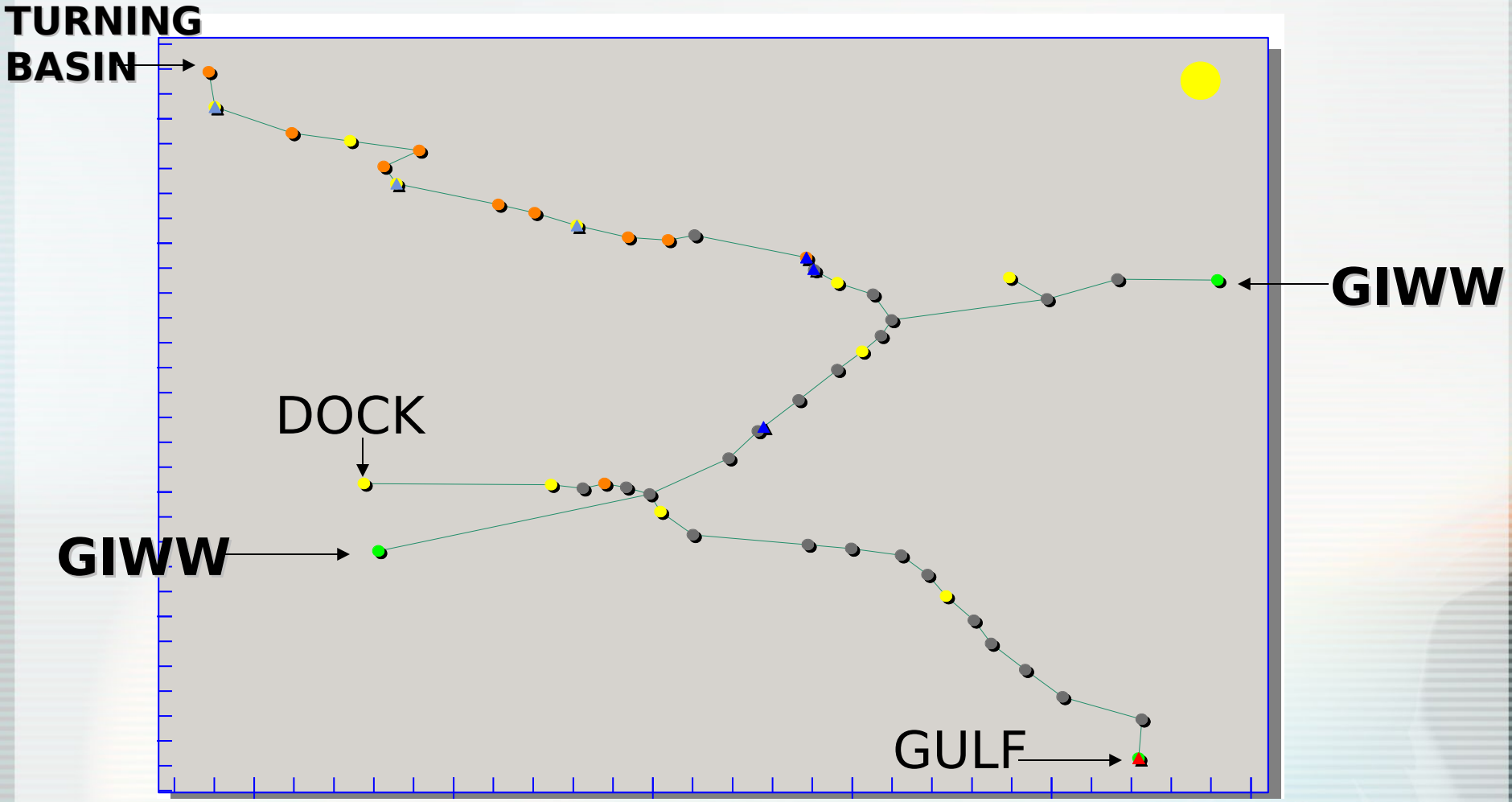
The Network

- **Nodes**
  - **system entry & exit nodes**
  - **turning basins and anchorages**
  - **topographic nodes (channel features)**
  - **virtual/aggregate dock nodes**

- **Starting/ Stopping Points**
  - **system entry & exit nodes**
  - **docks**
  - **turning basins/ anchorages**

Sabine Neches Waterway

The Network
Sabine Neches Waterway



Vessel Call Data Base

- **Unique Vessels**
  - **Vessel class**
  - **Physical characteristics**
- **Vessel Call**
  - **Arrival Time / Draft**
- **Dock Visits**
- **Commodity Transfers**
  - **Quantity / Commodity Category**
  - **Import/Export**
- **Microsoft Access Relational Database**

Vessel Movement on Network

- **Vessel moves on pre-determined (model calculated) route through reaches**
- **Leg – 3 types**
  - **Bar to Dock / Dock to Dock / Dock to Bar**
- **Transit Rules tested for Leg**
  - **Check rules / conflicts with other vessels**
  - **Vessels already in leg have priority**
  - **Wait until can proceed**
  - **Can move to intermediate anchorage/holding area**
- **Can wait at Bar, Dock, Holding Area if rule violation in Leg**

Vessel Movement

Vessel Begins Movement

% of transit time elapsed – 25% of distance is travel

% of transit time elapsed - 75% of distance is travel

Vessel Transit Rules

Single Vessel Rules

- **Restrictions by di**
- **I re**
- **T Ca**

Multiple Vessel Rules -

Transit Rule Type ID	Transit Rule Type	Transit Rule Type Description
1	No Rule	No Transit Rule
2	No Meeting Combined Beam Width	No Meeting - Max Combined Beam Width > input parameter
3	No Meeting Combined Draft	No Meeting - Combined Draft
4	No Meeting DWT Draft	No meeting – dwt/draft: Max DWT OR Max draft
5	No Meeting DWT Draft Either	no meeting - either vessel with dwt and draft greater than values

Commodity-Driven Forecast Tool

- **Assist in developing balanced / rational fleet and commodity forecasts**
- **Inputs**
  - **Commodity / Fleet / Constraints**
- **Methodology**
  - **Translate Annual Commodity Forecast to Vessel Calls**
  - **Use up fleet resource subject to constraints (Dock Draft Limitations, commodities, docks)**
- **Outputs for synthetic vessel calls for HarborSym**
  - **Forecast Satisfaction / Detailed Calls**
  - **By Dock, Commodity, Import/Export**
  - **Fleet Specification by class**
    - **Potential Calls / Priority**
    - **Statistical Description of Physical Characteristics**
  - **Loading Factor Distribution By Class/Commodity**

Current Simplifying Assumptions for Vessel Call Simulator

- **Each vessel call carries single commodity to/from a single dock**
- **Each vessel call is either import/export**
- **Yearly basis (no seasonality)**
- **No Tide**
- **Statistical method of generating vessel characteristics**
- **Assume vessels exporting from port arrive at minimum draft**
- **Constant inter-arrival time for a class of vessels**

Methodology – Vessel assignment

- **Generate set of distinct vessels based on fleet specification**
- **Loop through commodity demands**
  - **Find a vessel that can carry the commodity at the dock (subject to constraints)**
  - **Load it to maximum, subject to loading factor and depth limitation at dock**
  - **Reduce commodity demand at dock by amount loaded**
  - **Remove vessel from available set**
  - **Next demand**
- **Stop when:**
  - **no more suitable vessels available**
  - **or all forecasts satisfied**
- **Assign trip times**
- **Report results / store in database**

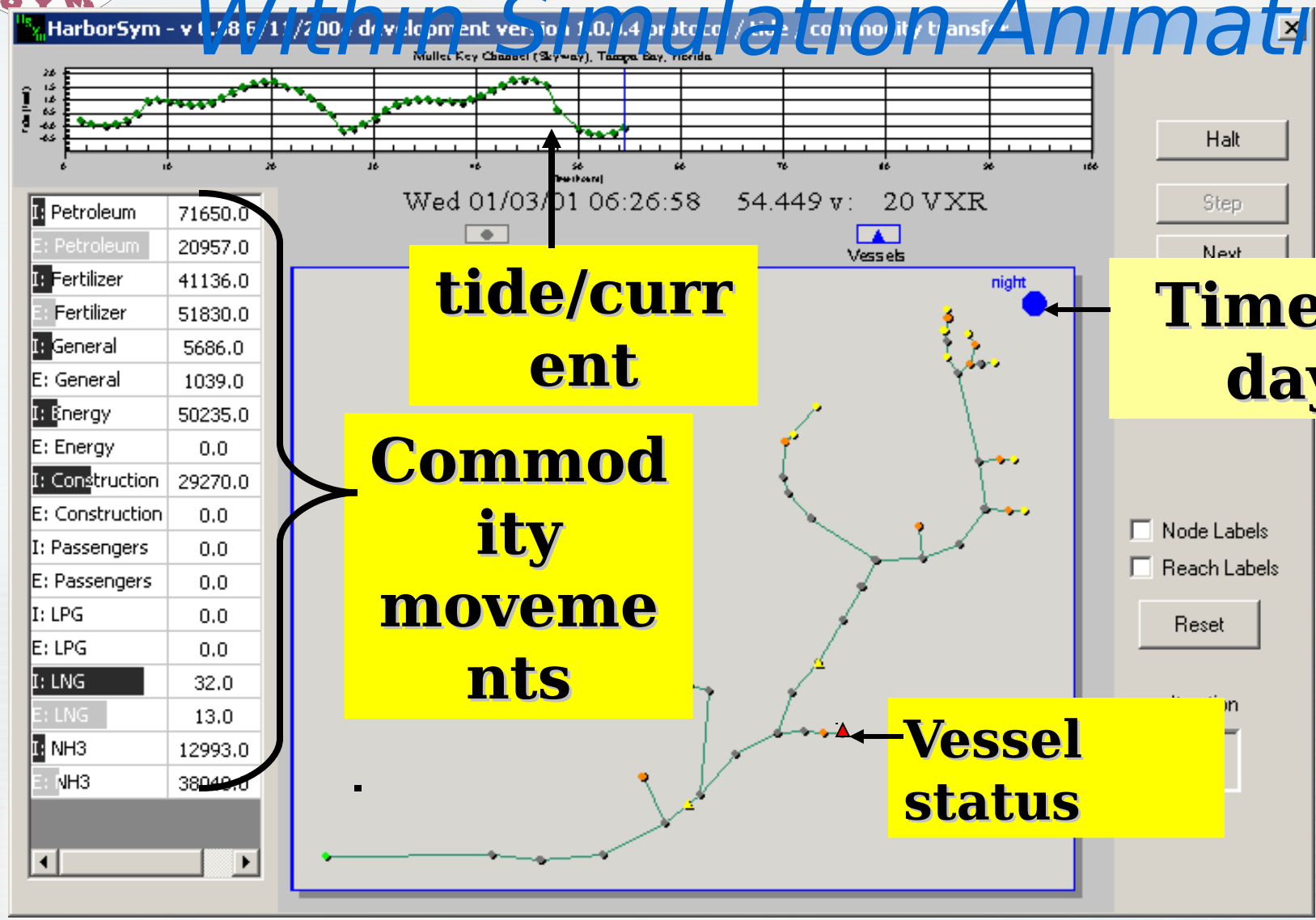
Forecast Tool Outputs - Forecast Satisfaction / Vesse Movements

Commodity	Dock	I/E	Quantity	Allocated	Deficit	% Deficit	# Calls
Crude	11 Exxon Mobil	I	2624988 1	7397000	1885288 1	71.82 %	122
Crude	7 Fina Oil	I	2014628 7	7344750	1280153 6	63.54 %	122
Crude	3 Chevron Motiv	I	9072806 2	6332825	2739980	30.20 %	109
Petroleum Products	5 Lone Star	I	69403	69403	0.00	0.00%	2
Petroleum Products	4 Premcor	E	204896	204896	0.00	0.00%	6

Arrival	DockCode	Commodity	Import Quantity	Export Quantity	Entry Draft	Name
1/4/2001 5:33:31 AM	6 DuPont	Crude	66703	0	69.3	OT2000
1/4/2001 1:07:14 PM	8 Union Oil	Crude	90526	0	69.6	OT4006
1/4/2001 6:09:29 PM	3 Chevron Motiv	Crude	38674	0	61.6	OT1000
2/28/2001 11:28:26 AM	8 Union Oil	Petroleum Products	0	28933	18	CT1019
3/5/2001 11:22:00 AM	11 Exxon Mobil	Petroleum Products	0	18162	20	BC1009
3/6/2001 5:37:56 AM	3 Chevron Motiv	Petroleum Products	0	45271	23	GC2009

Additional HarborSym Feature

Within Simulation Animation

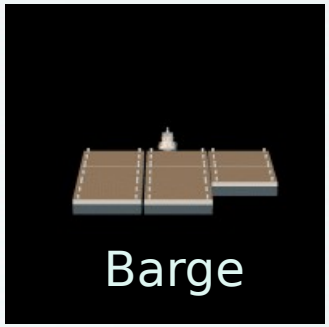


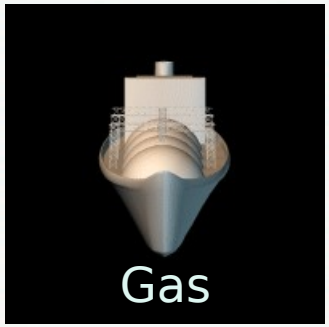
Capturing Benefits
HarborSym Output

Average Vessel Times Under Proposed Channel Improvements

	Existing Condition	Intermediate Improvement	All Improvements
Avg Ves Time in System	71.202	70.2	68.8
Avg Ves Time Waiting	10.2	9.2	7.9
Avg Ves Time Wait Entry	3.9	2.8	2.5
Avg Ves Time Wait Dock	4.9	5	2.7

Simulation Fleet Enhancements





- **Vessels have an ID from HarborSym**
- **Vessels are named**
- **Vessels have unique avatars by class**
  - **Location in 3-space (to start)**
  - **Orientation (upright)**
  - **Appearance (material applied to avatar)**

Limitations

- **Tree-structured network (no loops)**
- **Movement simplification**
  - **Vessels already in leg have priority of movement**
  - **No adjustment of speed in reach**
  - **No coordination of speeds**
- **No Induced Traffic**
- **No Tugs / Equipment Constraints**
- **Aggregation / Simplification of system usually required**

Training Exercises

- **Create a HarborSym Study**
- **Building the Network**
- **Defining Vessel Types**
- **Defining Commodities**
- **Importing Vessel Calls**
- **Defining Vessel Speeds and Times**
- **Running a Simulation**
- **Defining Transit Rules**
- **Review Simulation Report**
- **Channel Widening Project Alternative and Input Costs**
- **Tide, Current and Other Features**
- **An Additional Anchorage Project**

Training Opportunities

- **Have done some training for Corps planners**
- **Planning on new training session sometime this Fall, possibly on West Coast**
- **Is a training manual available, but not posted on website**

- **See HarborSym as beta test – part of ongoing improvement process**

PIANC USA – Introduction

- **What is PIANC?**
  - **A nonprofit organization of individuals, corporations, and national governments, with over 2500 members from 64 countries.**
  - **The U.S. Section has approximately 300 individual and corporate members.**
- **Mission: to advance, on a worldwide basis, the sustainable development of all kinds of navigation.**
- **5 Commissions**
  - **Inland Navigation**
  - **Maritime Navigation**
  - **Recreation Navigation**
  - **Environmental**
  - **International Co-operation**

PIANC USA – Other Items

- **Developing New Strategic Plan**
  - **Young Professionals**
  - **Adding Value to Members**
  - **International Partnerships**
  - **Domestic Partnerships**
- **PIANC USA working with Ports07**
- **OAS-CIP Meeting on the Environment next Spring**

For More Information

NETS http://www.corpsnets.us/

HarborSym http://www.pmcl.com/harbor

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